



Electronic Payment System: Types, Trends, and its Impacts on Thai Economy

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Abstract

Electronic Payment helps enhancing economic growth, promoting online trading, decreasing cash holding, and reducing friction in trade transactions, resulting in an increase in private consumption expenditure (PCE) and real gross domestic product (RGDP) in the country. There are various forms of E-payments; however, the examination of each type of E-payments regarding its trends and impacts on the emerging economy is still limited. The present study fills this gap by exploring types, trends, and relationships between E-payments and the impacts on Thai economy. Literature review was employed to explore the characteristics of each type of E-payments. Descriptive statistics was applied to explore the trends of E-payments during 2010-2020. Pearson correlations and regression analysis using Newey-West standard errors were employed to analyze the effects of E-payments growth on PCE growth and RGDP growth in Thailand. The results indicated that E-payments were significantly and positively related to PCE growth and RGDP growth. Payment transactions via Internet/Mobile banking and E-Money increased remarkably, while transactions via ATM cards decreased over time. Transactions via debit cards remained stable, whereas transactions via credit cards showed a slightly increasing trend. Credit cards, Internet/Mobile banking, and E-Money positively and significantly related to PCE growth and RGDP growth, while there were no relationships between ATM cards relating to PCE growth and RGDP growth in Thailand. Overall, a 1% growth in E-payments results in 0.13% growth in PCE and 0.12% growth in RGDP.

Keywords: *E-payments, Internet banking, Mobile banking, E-Money, private consumption expenditure growth, economic growth*

1. Introduction

Technological development has contributed to the development of online trading and E-commerce around the world. To enable the growth of online trading, there must be an effective payment system to underpin an increase in online transactions. Electronic payment system (or E-payments), defined as a payment service or the transfer of the right to hold money by utilizing electronic means or information and communications technology (ICT) such as Integrated Circuit card (IC), cryptography, and communication network (Raja, & Seetharaman, 1970), is a mechanism to spur the growth of trade and the economy. Previous studies (Aldaas, 2021; Zandi, Singh, & Irving, 2013; Zandi, Koropeckyi, Singh, & Matsiras, 2016) have indicated that E-payments can promote trade by providing a convenient method for consumers to transfer money as well as reducing transaction costs and cash holding for both consumers and merchants. For the overall economy, E-payments lessen friction in trade transactions, resulting in an increase in private consumption expenditure, production, employment, and economic growth.

Currently, there are various forms of E-payments. Most popular ones include (1) ATM cards, (2) Internet/Mobile banking, (3) debit cards, (4) credit cards, and (5) electronic money (E-Money) (Selfira, Abdillah, Harahap, & Muda, 2019; Yu, Hsi, & Kuo, 2002). Different types of E-payments have distinctive characteristics and advantages. For example, credit cards are easy to use allowing consumers to purchase before and pay later; however, transaction costs are high which is not suitable for small value purchases. E-Money, thus, is a more popular when making small value purchases (Selfira et al., 2019; Yu et al., 2002).

The trends of using different types of E-payments have changed over time. Credit cards have been popular mode of E-payments since the 1990s. However, there is an increasing trend of using Internet/Mobile payments to replace debit or credit card payments in Sweden (Aldaas, 2021). In advanced economies, credit cards are more likely to use for oversea transactions. With the growth of internet and mobile phone users, it

is expected that payments through Internet/Mobile payment and E-Money will significantly increase, while the use of debit cards will significantly decrease in the future. Particularly, with the widespread of the COVID-19, consumers are encouraged or compelled to purchase by making cashless payments. Besides, other alternative E-payments such as E-Money and E-wallet are available and being used by consumers.

The nature of trading and payments have been evolved over time from barter system to coin, paper currency, cheque, plastic money, and E-payments. With innovations and advanced technologies, E-payments allow remote transactions to become possible and traders can transact without actual money (Asokan, Janson, Steiner, & Waidner, 2000). According to VISA (2003), E-payments broaden network of trading, facilitate transactions between buyers and sellers as well as increase economic activities, stimulating economic growth and benefiting people around the world.

E-payments are convenient method enabling consumers to transfer money anytime and anywhere at lower transaction costs (VISA, 2003). Without E-payments, transfers of money must be performed at the counters with higher fees charged by banks and other institutions (Humphrey, Willeson, Lindblom, & Bergendahl, 2003). Further, with advanced technologies, E-commerce and E-payments provide consumers timely access to information (VISA, 2003) and increase consumer choices, granting them to buy goods and services at a lower price while enjoying higher satisfaction (Deloitte LLP, 2013).

To businesses, E-payments lead to incremental sales since they broaden customer coverage allowing them to make transactions anytime and anywhere. E-payments result in higher efficiency, inventory reduction, and better management of cost and cash flows (VISA, 2003). Besides, E-commerce and E-payments open opportunities for new business and enhance the growth of small and medium enterprises (SMEs) due to lower cost of setting up business online, leading to a greater competition and economic efficiency (Deloitte LLP, 2013).

For financial institutions, E-payment system results in lower cost and higher efficiency. Humphrey et al (2003) revealed that the banks' transaction costs of E-payments are only one-third to one-half of the paper-based payment. For example, transaction cost of E-payment (debit cards) accounts for 33% of a traditional paper-based transaction cost in Norway and 28% of check payment cost in Spain (Humphrey et al., 2003). E-payment system increases speed of transactions, security to clients, and customers' satisfaction, resulting in higher revenue and efficiency (Gupta, Yadav, & Bhardwaj, 2020; Sakanko, & David, 2019). Siddik et al (2016) discovered that E-banking positively contributes to the banks' return on equity from the analysis of 13 banks in Bangladesh during 2003-2013. The study of the financial sector's performance in Islamic countries indicated that all types of E-payments (i.e. Internet banking, Mobile banking, bank cards, point of sales (POS) machine, and ATM) positively affect net profit margin (Torki, Rezaei, & Razmi, 2020).

The impacts of E-payment system on the economy have been investigated for decades. E-payment system plays an important role in accelerating the economic growth (Slozko, & Pelo, 2014). All types of E-payment instruments allow consumers to conveniently make purchases and transfer funds. They stimulate consumption resulting in lower inventory, higher demand for goods and services, higher production, lower unemployment, and higher economic growth (Slozko, & Pelo, 2014). Moody's Analytics (2016) studied 70 countries/regions during 2011-2015, the results disclosed that payment cards (i.e. debit and credit cards) significantly promoted economic growth, creating 2.6 million jobs over the year 2011-2015, increasing GDP of 70 countries/regions by \$296 billion, and contributing to 0.11% increase in GDP for emerging countries and 0.08% for developed countries (Zandi et al., 2016).

However, less of previous literature has examined the characteristics and effects of E-payments in Thailand. Previous research has studied the impacts of E-payments on the economic growth; however, very few studies have classified and examined the trends of different types of E-payments. The relationships between different types of E-payments and economic variables such as trade, consumption, and growth are less investigated. Most previous studies have focused on the U.S. and European countries only. Few studies of E-payments have conducted in emerging economies, particularly in Thailand. Therefore, the present research will fill this gap by exploring the types, trends, and the relationships between E-payments and important economic variables such as private consumption expenditure growth and economic growth in Thailand.

Electronic payment system is a payment service that utilizes electronic means or information and communications technology (ICT) such as Integrated Circuit card (IC), cryptography, and communication

network (Raja, & Seetharaman, 1970). Electronic payments (or E-payments) facilitate the transfer of the right to hold money or withdraw money from the users' accounts with the service providers by electronic mean (BOT, 2008). E-payments encompass a variety of instruments such as ATM cards, Internet/Mobile banking, debit cards, credit cards, and E-Money.

There are four major parties involved in E-payments system including payer (consumer or buyer), payee (merchant or seller), issuer, and acquirer (see Figure 1). Payer and payee are considered as the demand side of the payment system, while issuer and acquirer are the supply side of the system (World Economic Forum, 2018). Issuer serves the payer in facilitating payment transactions, while acquirer facilitates the payee in collecting or clearing money. In some payment transactions, the issuer and the acquirer can be the same institution, mostly are commercial banks and financial institutions. However, recently, other powerful corporations (e.g. telecommunication corporations) can facilitate the settlement of E-payment transactions. Figure 1 shows the flow of money from the payer to the payee (Asokan et al., 2000; Harper, Simes, & Malam, 2006). When the consumer makes a payment, a certain amount of money is withdrawn from the consumer's bank account (issuer) and transferred to the seller's or the merchant's bank account. Then, the actual money flows from the issuer to the acquirer.

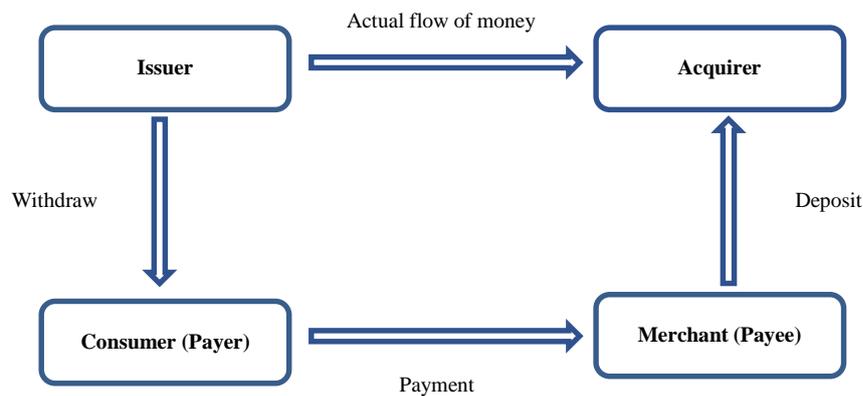


Figure 1 The transaction flow of E-payment system
Source: Adapted from Harper et al. (2006).

The benefits of E-payments can be explained by various plausible explanations. For the payer, E-payments provide convenience for customers to spend anywhere and anytime. Moreover, E-payments allow customers to assess all available funds including their line of credit; thus, purchasing are not limited to the amount of cash that customers hold on hand (Zandi et al., 2016). For the merchants, E-payments provide opportunities for E-commerce to grow by reducing the costs and complicated process associated with traditional cash payment. With E-payments, merchants can broaden their customer based and expand into online retail business with a guaranteed payment (World Economic Forum, 2018). Payments with Internet/Mobile banking, E-Money, and credit cards facilitate online purchasing-selling transactions and enhance trust between customers and the merchants (Zandi et al., 2016). Without E-payments, merchants may refuse to sell because of high risk in collecting cash on delivery. Merchants may be reluctant to accept checks for high-valued purchases due to high risk of nonpayment (World Economic Forum, 2018).

E-payments benefit customers, merchants, and policy makers, i.e. the Central Bank and the government. E-payments decrease the costs of issuing notes and coins as well as overhead costs on printing money (Zandi et al., 2016). Besides, E-payments can enhance transparency in business transactions (Zandi et al., 2016). With E-payments, data of all transactions are recorded; thus, it is difficult for the merchants to avoid tax payment. Without E-payments, the merchants can avoid paying tax by using cash payment and do not declare real revenues to the Revenue Department. Davit (2017) indicated that E-payments enable the government to effectively fight for illegal activities and fraud with the trace of all transactions.

For the overall economy, E-payments promote financial inclusion, economic efficiency, and growth, allowing low-income and remote consumers to have easy access to financial services. E-payments are efficient methods for the government to transfer funds and welfare to specific groups of people with less corruption (World Economic Forum, 2018). In addition, E-payments increase economic efficiency since they open opportunities for new firms to enter the market, increasing competitions, and thus resulting in lower price for consumers (Deloitte LLP, 2013). E-payments also increase demand for goods and services and consumption spending, resulting in lower inventory, higher production, lower unemployment, and stronger economic growth (Slozko, & Pelo, 2014).

Previous empirically studies have confirmed the positive influences of E-payments on the world economies. VISA (2003) indicated that the adoption of E-payments results in an increase in domestic and global economic activities, cost saving, and capital accumulation. According to the cross-sectional analysis of 50 countries in developed and developing economies, the results revealed that an increase in the existing share of E-payments in a country by a margin of 10% generates an increase in consumption spending by 0.5%. Comparing with a paper-based system, E-payments provide a cost saving of at least 1% annually. This reduction in costs results from an increase in velocity and lower frictions in economic activities. Additionally, E-payments are gateways drawing cash into the banking system. VISA (2003) indicated that there is a 10 percent shift of currency into deposits and other reserves that can be used to provide loans which can increase GDP by 1% annually.

Deloitte LLP (2013) studied online payments of 17 countries in Europe during 2005-2010. The results indicated that E-payments enable retail E-commerce, provide opportunities for new business, enhance SME growth, facilitate broader trade, and promote competition, resulting in lower price and greater choices for customers. Retail E-commerce enabled by E-payments contributed €125 billion in EU's GDP in 2012. A 1% change in online retail sales is associated with a 0.01% change in RGDP of a country (Deloitte LLP, 2013). In addition, the study on retail prices revealed that online selling prices were approximately 21% lower than that of offline in 15 product categories. Without online trades and payments, sales could have been reduced by €23 billion in 2012 (Deloitte LLP, 2013).

Zandi et al (2013) studied the effects of the payment cards usage (i.e. credit and debit cards) on the global economic growth in 56 countries (considered as 93% of the world's GDP) during 2008-2012. The results indicated that the usage of payment cards contributed \$983 billion to global GDP and created 1.8 million more jobs. Overall, a 1% increase in payment card usage contributed to an increase in consumption by 0.056% and GDP by 0.032% (Zandi et al., 2013). This analysis was extended by Zandi et al. (2016) using macroeconomic data from 70 countries during 2011-2015 with the result revealing that the usage of payment cards (i.e. credit, debit, and prepaid cards) constituted to higher RGDP in 70 countries by \$296 billion. Countries with the largest increase in card usage (i.e. Hungary) experienced the highest growth (0.25%) in RGDP. For emerging markets, a 1% increase in card usage contributed to 0.11% increase in RGDP. For developed countries, a 1% increase in card usage resulted in 0.08% increase in RGDP. However, the study of Zandi et al (2013) and Zandi et al. (2016) emphasized on the effects of payment cards only, Internet/Mobile banking and E-Money were excluded from the analysis.

J. P. Morgan (2019) studied E-commerce payment trends in Thailand and found that the value of online shopping sector in Thailand grew significantly at 48.7% growth in 2016 and 26.8% growth in 2017, implying that the growth in E-commerce drives the need for E-payments. In 2019, cards (debit and credit), which were the dominant E-payments method, accounted for 30% of the total E-commerce payment in 2019, while digital wallet, bank transfer, and cash accounted for 23%, 23%, and 15% of the value of E-commerce payment, respectively. With the growth in mobile phone penetration rate and the government's investment on digital infrastructure in Thailand, it was expected that digital wallet and mobile banking would significantly grow in the future (J. P. Morgan, 2019).

2. Objectives

The present research primarily aims at three objectives. The first objective is to explore the characteristics of five types of E-payments, including ATM cards, Internet/Mobile banking, debit cards, credit cards, and E-Money in Thailand. The second is to discover the trends of each type of E-payment usage in Thailand. The third objective is to examine the relationships between the growth of E-payments with respect

to consumption growth, measured by the growth of private consumption expenditure (PCE), and the economic growth, measured by the growth of real gross domestic product (RGDP), in Thailand.

3. Methodology

Previous literature on E-payments was reviewed to explain the distinct characteristics of five types of E-payments, i.e. ATM cards, Internet/Mobile banking, debit cards, credit cards, and E-Money. Data of five E-payments were obtained from secondary sources, while data of E-payment transactions and value were obtained from the Bank of Thailand (Bank of Thailand, 2021). Data of private consumption expenditure (PCE) and real gross domestic products (RGDP) during 2010-2020 were gathered from National Economics and Social Development Board (Office of the National Economic and Social Development Council, 2021) to investigate the last two objectives. Descriptive statistics was employed to explore the trends of E-payments in Thailand. Pearson correlations were utilized to analyze the relationships between the growth in value of each type of E-payments with respect to PCE growth and RGDP growth in Thailand. To eliminate the problem of autocorrelation and heteroscedasticity, regression analysis with Newey-West standard errors was employed to investigate the relationships between the growth of E-payments with regard to PCE growth and RGDP growth in Thailand.

4. Results

4.1. Characteristics of Each Types of E-Payments

Presently, with the development of ICTs, various E-payment instruments and methods including ATM cards, Internet/Mobile banking, debit cards, credit cards, and E-Money are commonly utilized in Thailand. The followings provide insights to each type of E-payment methods.

Automated Teller Machine (ATM) Cards

ATM cards have been widely adopted by consumers throughout the world for decades granting them to deposit money, withdraw cash, pay bills, and transfer money without the aid of tellers or counters' representatives. Account-based system users, consumers or users must establish or register their accounts with service providers (usually commercial banks). After registered for their accounts, users must maintain a minimum balance in their accounts. Once the transactions are made (i.e., withdrawals, transfers, or payments), the money is subtracted immediately from the users' accounts. In case that the users' balance is insufficient, the transactions cannot be successfully completed (Selfira et al., 2019).

While other types of E-payment transactions (i.e., Internet/Mobile banking, debit cards, credit cards, and E-Money) can be accomplished via online network anywhere, consumers who want to withdraw or transfer money via ATMs must travel to POS machine. POS machine is a combination of computer terminal and cash vault in which consumers can insert their ATM cards into the computer terminal using Personal Identification Number (PIN) (Nzaro, & Magidi, 2014). As such, ATM cards are not as convenient as other types of E-payments as transactions must be rendered at POS only, causing lower volume of ATM transactions in several countries over time including in Thailand.

Internet/Mobile Banking

Currently, payments or transfers of money via Internet and mobile phone have been extensively embraced in numerous countries. With remarkable growth in the Internet adoption and mobile phone penetration rate, Internet/Mobile banking is considered the most convenient payment methods. It supports online or E-commerce as well as offline purchase transactions (VISA, 2003). Though the purchases are made at the physical counters, consumers can still make payments or transfer money via Internet/Mobile banking using QR codes or other technologies. Thus, Internet/Mobile banking decreases cash holding by consumers, decreases transaction costs with each payment, stimulates consumption, provides opportunities for startups and SMEs, promotes financial inclusion, and stimulates economic growth. It is considered as a high security payment with a low transaction cost, making it suitable for small purchases or micro-payments. Merchants can record information about customers and purchase history data for making business strategies and marketing plan in the future (VISA, 2003).

Debit Cards

The Bank of Thailand Notification (2018) defines a debit card as “an electronic card issued by the service provider to its user for the payment of goods, services, or other payments in lieu of cash, or for withdrawing, debiting, transferring, or other transactions related to money in accordance with the value of money that user has deposited with the service provider”. Similar to ATM cards, debit cards’ users must establish accounts with the service providers with a required minimum balance. Debit cards work as hybrid instruments between ATM cards and credit cards which can be used to withdraw cash like ATM cards as well as purchase goods and services at POS without carrying cash like credit cards. Once the purchases are made, debit cards are swiped, money is deducted immediately and directly from the users’ personal accounts (Selfira et al., 2019; VISA, 2003; Abrazhevich, 2001).

The advantages of using debit cards are convenience, low cost, and scalability. Consumers can present only an account number (without a physical card) to the sellers (Selfira et al., 2019; VISA, 2003) to purchase goods and services. Consumers and merchants are not required to create more infrastructure to support such transactions. The fees charged for consumers and merchants are lower than that of credit cards, resulting in a lower transaction cost and thus making debit cards more suitable for small purchase transactions (or micro payments) than credit cards. Scalability is the ability of payment system to handle additional users and merchants without degrading the performance of the system (Abrazhevich, 2001). When a new consumer establishes a new account, the system simply records the information and increases the number of accounts. Unlike a token-based system or E-Money, it needs systems to support a large database to track all tokens and transactions made (Abrazhevich, 2001).

Credit Cards

Credit cards allow consumers to purchase with credit. They allow consumers to borrow with an approved line of credit to purchase goods and services and obtain cash in advance with an agreement to payback later (Selfira et al., 2019). The amount of credit limit differs among credit cardholders depending on their creditworthiness. The transaction is rejected if the payment is beyond the credit limit. Once the transaction is made, consumers will receive a bill to pay later (usually within one month). If a consumer is unable to pay the total balance when due, the consumer is subjected to fees and interest charged by the credit card service provider (Selfira et al., 2019; VISA, 2003).

The major advantage of credit cards is also convenience. Purchasing is easy; consumers can swipe or insert physical cards at POS or provide the credit card numbers to merchants for online payments. There is no need for consumers to install new hardware or software using the payment cards (Abrazhevich, 2001). Credit cards allow consumers to purchase without having bank accounts and cash on hand. Consumers can also cash out from credit cards in advance. Credit cards’ scalability and acceptability are high. The ability of the system to support more users is high; as a result, there is a large scale of consumers using credit cards. With a massive customer base, many merchants are willing to join the system and accept credit cards as an effective mean of payment (Abrazhevich, 2001). While using credit cards encourages consumers to spend more, increases consumption expenditure, and enhances economic growth, overspending or misuse of credit cards can result in over-indebtedness and harmful to the economy. Thus, regulations and education on using credit cards must be properly addressed.

Security and transaction costs are two major issues in previous studies. Initially, credit cards received less attention because of the security concern. However, with the development of security in payment system technologies, such as Secure Electronic Transaction (SET) used by Visa and Mastercard, credit card transactions become more secure from hackers and fraud (Abrazhevich, 2001). With SET protocol, the entire credit card number is not permitted to travel across the system, only part of the number is visualized by human. Furthermore, SET operates on the mutual authentication with a payment gateway and certified authority to authorize the card usage. As such, the authorization request is transmitted by the merchant to the acquirer when a payment is made (see Figure 1).

Then, the purchase instruction of the consumer is dispatched to the issuer and the acquirer to mutually verify all purchase information. With the secure payment procedure and mutual authentication, yet time consuming, using credit cards gain more attention and trust from consumers around the world. However, the transaction costs are high as merchants or consumers are exposed to fees charged per transaction (about

2%-3% of the value purchase). As such, credit cards are not suitable for consumers making small value purchases, small businesses (Selfira et al., 2019; VISA, 2003; Abrazhevich, 2001), or micro-payments (Koponen, 2006).

E-Money

Bank of Thailand (2008) defines E-Money as “an electronic card issued by the service provider for its user, whether it is specified the name or not. The user shall pay money in advance to the service provider in order to use such electronic money for the payment of goods, services, or other payments in lieu of cash and the value or amount of the prepaid money has been recorded”. E-Money is a prepaid card which the amount of money is recorded and stored in an electronic instrument (i.e., electronic card) to pay for goods and services (Selfira et al., 2019). E-Money provides consumers more convenient to shop without holding cash with timely transactions through plastic cards or mobile phone.

Characteristics of E-Money are differed from debit and credit cards. Regarding the payment period, users of E-Money must pay or top up money with the service providers into cards before purchasing (prepaid). Debit cards’ users pay at the time of the purchase, while credit cards’ users pay later after the purchase with no record of funds in the cards ((Selfira et al., 2019). Regarding the authorization, users of E-Money have a full control over their funds. Payments via E-Money can be completed without the need to contact the central control system (Abrazhevich, 2001); however, the service providers must authorize the funds transferred when making payment transactions with debit and credit cards ((Selfira et al., 2019). Payments via E-Money can be performed offline, whereas payments via debit and credit cards must be completed online only (Selfira et al., 2019). Offline transaction means transaction that can be performed without being connected to the network and having the third party (issuer) as a mediator (Abrazhevich, 2001). Hence, funds can be transferred from consumers to merchants offline when making payments via E-Money where verification is attained at the POS or at the merchant level without online authorization from the issuer. However, making payments via debit and credit cards, online access to the issuer is obliged to obtain authorization from the issuer before money is debited from a consumer’s account. Thus, credit and debit cards cannot be utilized if there are network problems (Selfira et al., 2019).

E-Money is a roadmap to less-cash and cashless society providing several advantages to consumers, merchants, and the economy comparing to traditional cash payment method. E-Money provides convenience to consumers as they can make purchases without holding cash and can make exact payment without receiving changes. Reduction in cash (paper or coin) holding can help lessen the risk of the COVID-19 infection. Payments via E-Money can be accomplished more efficiently, without central authorization process, and faster at lower costs than debit and credit cards. Therefore, E-Money is more suitable for micro payments than other payment cards (Abrazhevich, 2001). Besides, E-payments provide anonymity, referring to a transaction that the customer’s identity is not revealed (Bezovski, 2016). Consumers’ names and identity are not disclosed; thus, purchasing information is kept privacy. Table 1 summarizes the characteristics of each type of E-payments being explored in this study.

Table 1 Characteristics of each type of E-payments

Characteristics	ATM Cards	Internet/ Mobile Banking	Debit Cards	Credit Cards	E-Money
Acceptability	Yes	Yes	Yes	Yes	Yes
Authorization	Yes	No	Yes	Yes	No
Required bank account	Yes	Yes	Yes	No	No
Payment period	Cash withdrawn automatically at the time of Transactions			Purchase before and pay later	Prepaid
Transaction record in the card/instrument	No	Yes	No	No	Yes
Transaction cost	High	Low	Low	High	Low
Suitable for micro-payments	Yes	Yes	Yes	No	Yes

Characteristics	ATM Cards	Internet/ Mobile Banking	Debit Cards	Credit Cards	E-Money
Additional hardware, software or application installation needed	No	Yes	No	No	Yes
Anonymity	No	No	No	No	Yes

4.2. Trend of E-payments in Thailand

Total E-payment transactions in Thailand have grown remarkably over a decade, constituted a major part of payments, accounted for 91.19% of the total payment in 2020 compared to 76.88% in 2010. Total number of E-payment transactions in Thailand has been increasing tremendously, from 1,125.88 million transactions in 2010 to 13,339.765 million transactions in 2020, representing 1,085% growth in E-payment transactions (see Figure 2).

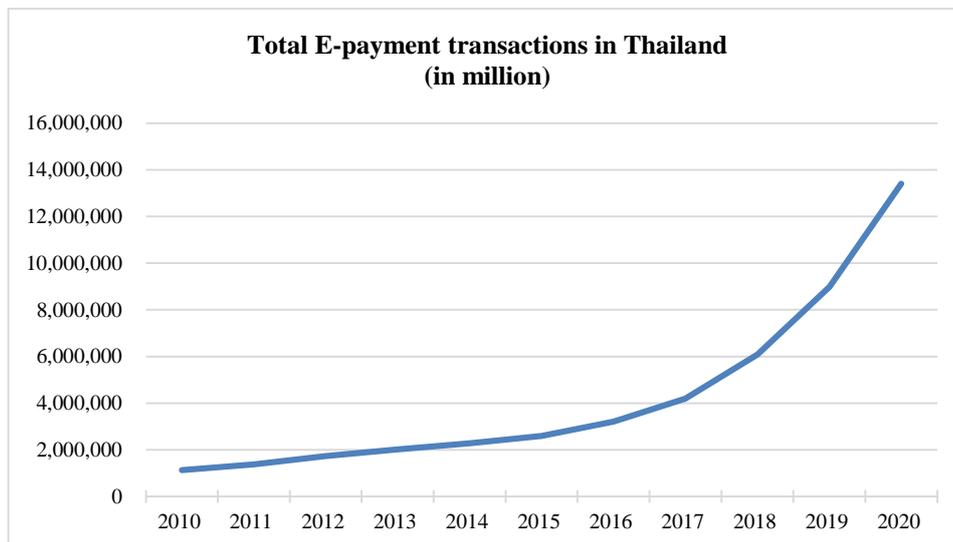


Figure 2 Total E-payment transactions in Thailand (in million)

The total value of E-payments in Thailand also shows an upward trend, from 171,948 billion baht in 2010 to 443,650 billion baht in 2020, demonstrating 158% increase over a decade (see Figure 3). The higher growth in the number of transactions than the growth in value may partly result from an increasing number of small purchases or micro payments due to the development of communication network and new technologies which help reducing transaction costs associated with each payment, making small purchases become possible, accessible, cheaper, and easier.

The significant increase of E-payment transactions in Thailand has commenced since 2016, partly resulted from the National E-payment Master Plan initiated by the Bank of Thailand attempting to create and integrate E-payment infrastructure to facilitate the transfer of funds for consumers, businesses, and government with the objective to develop infrastructure, E-tax system, E-social welfare, and financial inclusion, moving Thailand to the cashless society, with four projects including (1) PromptPay (Any ID payment), (2) Card Acceptance Expansion, (3) E-Tax, and (4) Government E-payment (National E-payment, 2016). PromptPay, initiated in 2016, has increased the number of E-payment transactions significantly, allowing consumers to transfer funds across banks or pay bills using their citizen identification (ID) number or mobile phone numbers instead of using traditional bank account numbers.

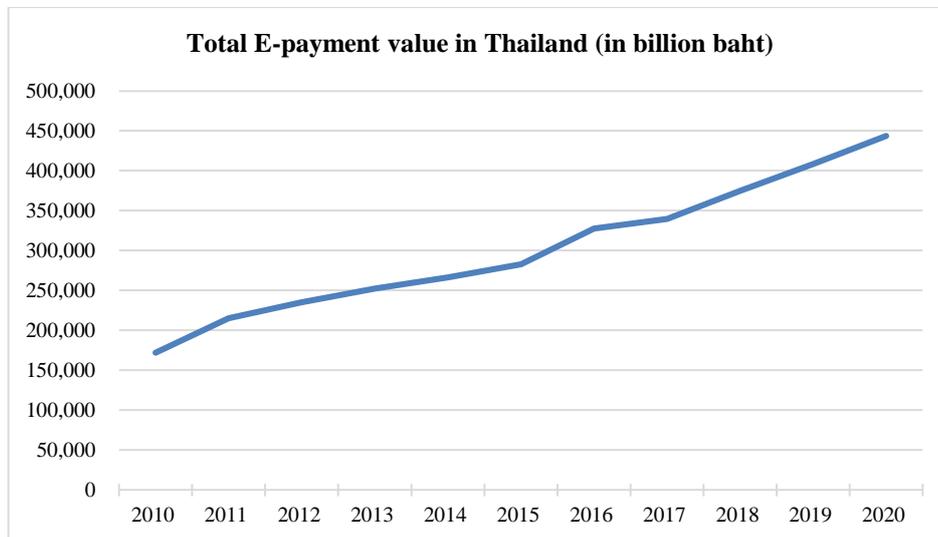


Figure 3 Total E-payment value in Thailand (in billion baht)

PromptPay also connects to E-Tax and government E-payment as a channel to transfer tax refund and social welfare payments. In 2017, there were about 880.4 million transactions completed via PromptPay comparing to 1,037.6 million transactions in 2018, 2,567.9 million transactions in 2019, and 5,306.1 million transactions in 2020. The value of transfer of funds via PromptPay has also increased remarkably from 327.09 billion baht in 2017 to 20,806.54 billion baht in 2020 (BOT, 2021).

In 2020, with the COVID-19 pandemic, consumers' behavior and lifestyles have changed tremendously, turning themselves to shop online and make payments via mobile phones. Besides, government E-payments have been implemented since late 2020 to transfer funds and welfare to relieve the impacts of the COVID-19, such as Rao Chana (means we win), Kon La Krung (means co-pay), and RaoRukKun (means we love one another), where funds from relief package are transferred to G-wallet (named Paotang). Users must install mobile application, G-wallet, to receive funds transferred from the government and use funds via G-Wallet to make payments; therefore, the number of payment transactions and funds transferred via mobile phones has increased dramatically. A substantial increase in Mobile banking plays an important role to promote financial inclusion, driving Thailand towards less-cash society and cashless society in the future.

Figure 4 illustrates the number of E-payment transactions by different types of E-payments in Thailand; ATM card transactions have shown a downward trend since 2016. Debit card and credit card transactions have slightly increased during 2010-2020, while the payments through Internet/Mobile banking and E-Money have displayed significantly upward trends over a decade.

The number of ATM cards decreased from about 18.56 million cards in 2010 to about 10.69 million cards in 2020 (see Table 2). While the number of ATM payments decreased, the number of transactions made via Internet/Mobile banking remarkable increased (see Figure 4). The number of mobile phones subscriptions increased dramatically over a decade from 71.73 million subscribers in 2010 to 129.61 million subscribers in 2019. Mobile phone penetration rate increased significantly from 112.28% in 2010 to 194.73% in 2019 (see Table 3). As such, the number of E-payment transactions via Internet/Mobile banking substantially increased.

E-Money is another type of E-payments showing a significantly upward trend in Thailand. The value of E-Money increased from 18 billion baht in 2010 to 310 billion baht in 2020 (see Figure 5). The number of E-Money transactions also rose from about 221.46 thousand transactions in 2010 to 2,136.15 thousand transactions in 2020 (see Figure 4). In 2018, there were 30 E-Money service providers in Thailand including banks and non-banks such as PTT blue card, mPay, Airpay, Rabbit, rabbit Line Pay, Smart Purse, LAZADA Pay, K-plus, and True money wallet.

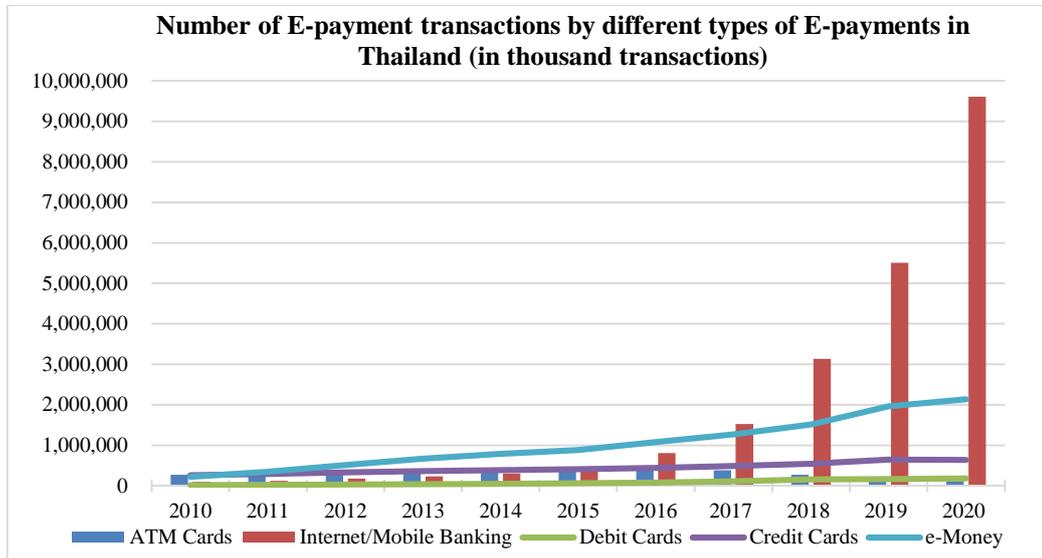


Figure 4 Number of E-payment transactions by different types of E-payments in Thailand (in thousand transactions)

Table 2 Number of E-payment users in Thailand

Year	Number of Population (in million persons)	Number of ATMs (cards)	Number of Debit Cards (cards)	Number of Credit Cards (cards)	Number of Mobile Phone Subscribers (in million persons)
2010	63.88	18,562,689	33,367,315	14,187,815	71.73
2011	64.08	16,201,587	37,363,365	15,328,291	77.45
2012	64.46	15,171,998	40,678,603	16,870,025	85.01
2013	64.79	14,699,210	42,343,959	18,548,754	92.94
2014	65.12	14,215,370	44,823,517	20,303,751	97.10
2015	65.73	13,397,755	46,989,719	18,974,195	102.94
2016	65.93	10,791,481	50,199,427	20,136,341	119.67
2017	66.19	8,758,043	54,329,727	20,334,780	121.53
2018	66.41	7,070,699	57,408,209	22,105,472	125.10
2019	66.56	15,318,234	64,772,849	23,998,653	129.61
2020	69.79	10,688,019	64,051,972	24,603,787	n/a

Table 3 E-payment penetration rate in Thailand

Year	ATM Penetration Rate (%)	Debit Card Penetration Rate (%)	Credit Card Penetration Rate (%)	Mobile Phone Penetration Rate (%)
2010	29.06	52.23	22.21	112.28
2011	25.28	58.31	23.92	120.86
2012	23.54	63.11	26.17	131.88
2013	22.69	65.36	28.63	143.44
2014	21.83	68.83	31.18	149.10
2015	20.38	71.49	28.87	156.61
2016	16.37	76.14	30.54	181.51
2017	13.23	82.08	30.72	183.61
2018	10.65	86.45	33.29	188.37
2019	23.01	97.31	36.06	194.73
2020	15.31	91.78	35.25	n/a

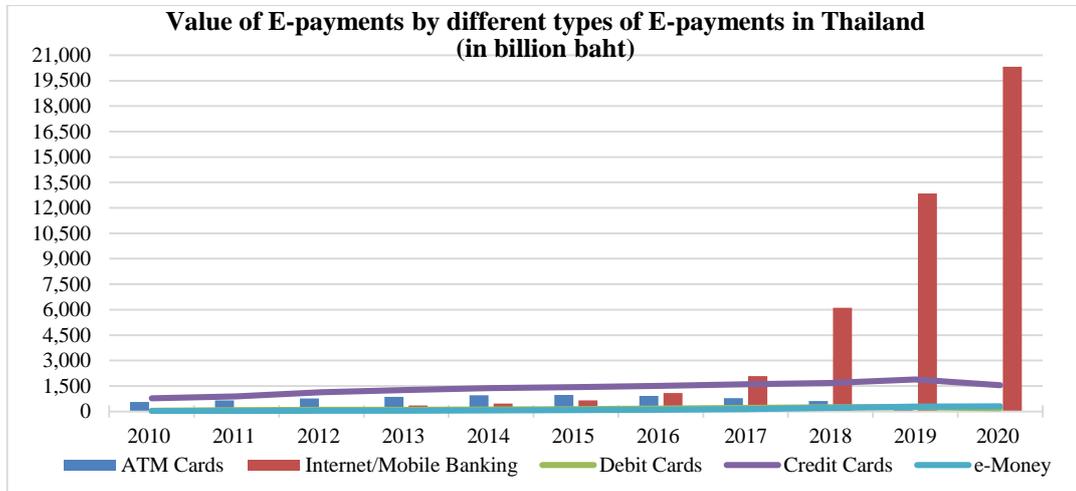


Figure 5 Value of E-payments by different types of E-payments in Thailand (in billion baht)

During the COVID-19, people prefer contactless payments such as mobile banking or E-Money to cash payment to reduce the infection risk since funds can be transferred hygienically without physical contacts. Less-cash society also reduces congestion or queues at banks, resulting in faster transactions. It also lowers transaction costs to the Central Bank by reducing the cost of printing banknotes, coin production, and transportation as well as to commercial banks by reducing the costs of operating branches.

4.3 Relationship between E-payments with respect to Private Consumption Expenditure and Economic Growth

To examine relationships between the E-payments growth with respect to private consumption expenditure (PCE) growth and economic growth in Thailand, quarterly data during 2010-2020 were analyzed. Table 4 revealed the relationships between the growth of each type of E-payments with respect to PCE growth and RGDP growth in Thailand. The results from Pearson correlation indicated that the correlations between the growth of Internet/Mobile banking ($r = 0.481$, $p < 0.01$), credit cards ($r = 0.606$, $p < 0.01$), and E-Money ($r = 0.616$, $p < 0.01$) were positively and significantly correlated with PCE growth at 0.01 significance level. As the growth in value of Internet/Mobile banking, credit cards, and E-Money expands, PCE also grows. However, the correlations between the growth in value of ATM cards and debit cards were not significantly related to PCE growth.

Table 4 Correlations between the growth of each type of E-payments with respect to private consumption expenditure growth and economic growth in Thailand

		ATM Cards	Internet/Mobile Banking	Debit Cards	Credit Cards	E-Money
PCE	Pearson Correlation	.170	.481**	.041	.606**	.616**
	Sig. (2-tailed)	.295	.002	.802	.000	.000
	N	40	40	40	40	40
RGDP	Pearson Correlation	.385*	.351*	.124	.758**	.561**
	Sig. (2-tailed)	.014	.027	.445	.000	.000
	N	40	40	40	40	40

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

Regarding the economic growth, the results indicated that the correlations between the growth of ATM cards ($r = 0.385$, $p < 0.05$), Internet/Mobile banking ($r = 0.351$, $p < 0.05$) with respect to RGDP growth were positively related at 0.05 significance level, while the correlations between credit cards ($r = 0.758$, $p <$

0.01), E-Money ($r = 0.561, p < 0.01$) with regard to RGDP growth were positively related at 0.01 significance level. Payments via ATM cards, Internet/Mobile banking, credit cards, and E-Money positively correlated to RGDP growth, implying that as payments via ATM cards, Internet/Mobile banking, credit cards, and E-Money increase, the economic growth in Thailand enhances. In addition, the strong relationship between the growth in value of credit cards and RGDP growth is discovered with a correlation coefficient of 0.758, indicating that the use of credit card payments can significantly stimulate private consumption expenditure, vice versa. However, the growth in value of debit cards was not significantly correlated to RGDP growth, suggesting that there was no significant relationship between the use of debit cards and economic growth in Thailand.

In addition, the present study examined the influence of E-payments growth on PCE growth and RGDP growth using regression analysis with Newey-West standard errors. Running time series data with a regression often exhibits problems of autocorrelation and heteroscedasticity in the model's error terms, using Newey-West regression technique can help overcome these problems. To test the effects of the E-payments growth on PCE growth and RGDP growth, the growth of total E-payments was calculated based on the percentage change year on year (% Δ yoy). Due to the limited number of observations, separating each type of E-payments into five independent variables may not be appropriate. As the data were collected during the COVID-19 period, which may pose significant influences on PCE growth and economic growth, a dummy variable was added to incorporate the effect of the COVID-19 on PCE growth and RGDP growth. The following model was applied to test the effects of E-payments growth on private consumption expenditure growth.

$$C = b_0 + b_1EPAYMENT + b_2D$$

Where: C = The growth in private consumption expenditure (% Δ yoy)
 EPAYMENT = The growth in E-payments (% Δ yoy)
 D = The dummy variable (D = 0 in the period with no COVID-19
 = 1 in the period of COVID-19)

Table 5 shows the influence of the E-payments growth on private consumption expenditure in Thailand. The results indicated that the growth of E-payments significantly influenced PCE growth at 0.001 level ($b = 0.1275, t = 2.7183, p < 0.01$), owing to their convenience and lower transaction costs in trades. The 1% increase in E-payments growth resulted in approximately 0.13% increase in private consumption expenditure in Thailand. The dummy variable ($b = -0.0437, t = -11.8401, p < 0.01$), was negative and significant as expected revealing that the COVID-19 pandemic resulted in a significant decrease in PCE growth.

Table 5 The effect of E-payments growth on private consumption expenditure growth in Thailand

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.011102	0.009163	1.211501	0.2334
EPAYMENT	0.127494	0.046902	2.718334	0.0099
DUMMY	-0.043732	0.003694	-11.84010	0.0000
R-squared	0.379700	Mean dependent var		0.027000
Adjusted R-squared	0.346170	S.D. dependent var		0.033832
S.E. of regression	0.027357	Akaike info criterion		-4.287679
Sum. Squared resid	0.027690	Schwarz criterion		-4.161013
Log likelihood	88.75358	Hannan-Quinn criter		-4.241881
F-statistic	11.32427	Durbin-Watson stat		0.935913
Prob (F-statistic)	0.000146	Wald F-statistic		76.80795
Prob (Wald F-statistic)	0.000000			

Dependent Variable: CONSUMPTION

Method: Least Squares

Sample (adjusted): 5 44

Included observations: 40 after adjustments

HAC standard errors & covariance (Prewhitening with lags = 3 from AIC
 maxlags = 3, Bartlett kernel, Newey-West fixed bandwidth = 4.0000

In addition, the present study examined the effect of E-payments growth on RGDP growth using the following model.

$$Y = b_0 + b_1EPAYMENT + b_2D$$

Where: Y = The growth in real gross domestic product (% Δ yoy)
 EPAYMENT = The growth in E-payments (% Δ yoy)
 D = The dummy variable (D = 0 in the period with no COVID-19
 D = 1 in the period of COVID-19)

Table 6 displays the significant influence of E-payments growth on RGDP growth in Thailand. The results revealed that the growth in E-payments positively and significantly associated with the growth in the Thai economy ($b = 0.1178$, $t = 2.2072$, $p < 0.05$). A 1% increase in E-payments resulted in approximately 0.12% increase in RGDP in Thailand. The dummy variable ($b = -0.0938$, $t = -19.4863$, $p < 0.01$) was significant and negative as expected implying that the COVID-19 pandemic significant decreased RGDP growth.

Table 6 The effect of E-payments growth on real gross domestic product growth in Thailand

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.012898	0.011521	1.119565	0.2701
EPAYMENT	0.117816	0.053377	2.207231	0.0336
DUMMY	-0.093811	0.004814	-19.48629	0.0000
R-squared	0.639787	Mean dependent var		0.022250
Adjusted R-squared	0.620316	S.D. dependent var		0.039710
S.E. of regression	0.024469	Akaike info criterion		-4.510820
Sum. Squared resid	0.022152	Schwarz criterion		-4.384154
Log likelihood	93.21640	Hannan-Quinn criter		-4.465022
F-statistic	32.85845	Durbin-Watson stat		1.378955
Prob (F-statistic)	0.000000	Wald F-statistic		227.1175
Prob (Wald F-statistic)	0.000000			

Dependent Variable: GDP

Method: Least Squares

Sample (adjusted): 5 44

Included observations: 40 after adjustments

*HAC standard errors & covariance (Prewhitening with lags = 3 from AIC
 maxlags = 3, Bartlett kernel, Newey-West fixed bandwidth = 4.0000*

In summary, the results of correlation and Newey-West regression confirmed the positive and significant impacts of E-payments growth on PCE growth and RGDP growth in Thailand. A 1% growth in E-payments results in 0.13% growth in PCE and 0.12% growth in RGDP.

5. Discussions and Conclusions

The present paper explores the characteristics of various types of E-payments (i.e., ATM cards, Internet/Mobile banking, debit cards, credit cards, and E-Money), trends, and their relationships with private consumption expenditure (PCE) growth and economic growth (RGDP) in Thailand. Various types of E-payments have different attributes and benefits. First, ATM cards are not as convenient as other modes of E-payments, resulting in a lower number of ATM cards and transactions as well as the value of funds transferred in Thailand since 2010. Correlation also showed no relationship between ATM cards and PCE growth.

Second, Internet/Mobile banking is the most popular E-payment method in Thailand since 2017. With ICTs and National E-payment Master Plan, Thai consumers are urged or compelled to use mobile phones as a channel to receive benefits. These factors constitute an upward trend of using Internet/Mobile banking in Thailand over time, with about 195% mobile phone penetration rate in 2019 (see Table 3). Internet/Mobile banking has positive correlations with PCE growth and RGDP growth, indicating that more payments via Internet/Mobile banking stimulate higher private consumption and economic growth in Thailand.

Third, the use of debit cards in Thailand has been stable over a decade; however, with the ICT development, Thai consumers prefer using Internet/Mobile banking to debit cards. However, the result shows no relationship between the growth in value of debit cards with respect to private consumption growth and economic growth in Thailand.

Fourth, with borrowing characteristics, credit cards stimulate households' consumption and economic growth. The positive relationship between credit cards and private consumption is stipulated, suggesting that higher use of credit cards promotes private consumption expenditure. The strong and positive relationship between credit cards and RGDP growth also implies that higher use of credit cards accelerates the economic growth in Thailand.

Fifth, the number of transactions and values of payment via E-Money and Internet/Mobile banking in Thailand have shown an upward trend resulted from an increase in the number of E-Money service providers and changes in consumers' lifestyles. To avoid the COVID-19 infection, consumers use more E-payments such as E-Money and Internet/Mobile banking. Thus, E-Money indicates the positive and significant relationship with private consumption growth and economic growth in Thailand.

Finally, the positive impacts of E-payments on private consumption expenditure and RGDP confirm that E-payments reduce friction in economic activities, decrease transaction cost, and enhance economic activities and trades.

The accelerate growth in the use of E-payments under the COVID-19 pandemic has driven Thailand to move faster towards less-cash and cashless society. Contactless payments such as Internet/Mobile banking and E-Money have paved the ways people transfer funds and make payments in the future. According to VISA Consumer Payment Attitudes Study 2020, National E-payment Master Plan and changes in consumers' lifestyles may prompt Thailand to become cashless society before the projection of 2030 (The Nation Thailand, 2021).

6. Limitations and Suggestions for Future Research

Due to the limitation in the number of observations, the regression analysis on each type of E-payments (i.e. ATM cards, Internet/Mobile banking, credit cards, debit cards, and E-Money) in regard to PCE and RGDP may not be highly appropriate. The present paper explored only the relationships between the growth of overall E-payments (in aggregate value) with respect to growth in PCE and RGDP using Newey-West regression method. Future research may incorporate more data and establish model to investigate and compare the influences of each type of E-payments on economic activities. In addition, current studies of E-payments in several countries particularly in emerging economies are still limited. Future research may extend the study in other emerging countries to discover whether the trends and effects of E-payments are evident across nations.

The present study hypothesized that E-payments enhance private consumption and economic growth. However, the relationships between E-payments and economic growth can be in different ways: E-payments may lead to the economic growth, or the economic growth may lead to more usage of E-payments, or both. Future research may investigate this issue by developing models to empirically test the causation from E-payments to the economic growth. Moreover, most of the current studies have emphasized the positive influences of E-payments. Future research may investigate the negative influences of E-payments on economy, for example, since E-payments allow customers to assess all funds available and line of credit (i.e. credit card), it may result in a significant increase in consumer debts and household debts. Current consumption may increase at the expenses of future consumption, resulting in lower consumption and economic growth in the future. Future research may examine this issue to raise concern and suggest appropriate policies to enhance the usage of E-payments.

The securities of using E-payments are another concern. To enhance the use of E-payments, technological development in terms of infrastructure and software must be available to increase the trust of users. Future research may investigate how technology can help increase securities, how securities can enhance trust and consumptions, and how regulations and policies should be implemented to increase securities of the E-payment systems. The effects of E-payments on money supply can be further explored. E-payments may influence velocity of money and the amount of money supply circulated in the economy. Future research may examine these issues to investigate how E-payments influences money supply and the

implementation of the Central Bank's monetary policies. Finally, with the COVID-19 pandemic, consumers' lifestyles and behavior change enormously. This could have significant impacts on the use of E-payments and economic activities. Future research may investigate the change in E-payments behavior under the COVID-19 and predict the trends of E-payments after the COVID-19.

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